PAPUA LNG PROJECT

UPSTREAM ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2: ENVIRONMENTAL AND SOCIAL BASELINE STUDIES

Part 6: Upstream Terrestrial Biodiversity Baseline Report
Annex 1c: Upstream Weeds Baseline Report

TOTAL E&P PNG LIMITED

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Upstream Weeds Baseline Report
Papua LNG Project

Total E&P PNG Limited

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EXECUTIVE SUMMARY

Joint venture partners are currently planning the development of the Elk-Antelope gas field, which is located within Petroleum Retention License 15 (PRL-15) in Gulf Province, Papua New Guinea. Total E&P PNG Limited (TEP PNG), a wholly owned subsidiary of TOTAL has the largest interest in the Elk-Antelope gas field and is the operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

As part of the Project environmental, social and health impact assessment (ESHIA), a terrestrial biodiversity study has been commissioned to provide a baseline characterization of terrestrial biodiversity and conservation values present in the vicinity of the upstream Project area. This report presents the results of the technical study on weeds conducted as part of the terrestrial biodiversity study. The study was undertaken with the objective of assessing the presence and status of non-native (i.e. exotic) weeds present within the study area.

Study area: The study area for the weed assessment includes the following:

- PRL-15 which comprises an area of 763,522 ha.
- The proposed pipeline export corridor which comprises an area of 208,761 ha.
- Sites outside of the PRL-15 and the export pipeline corridor that were visited as part of other Upstream Environmental and Social Baseline Study (ESBS) surveys completed as part of the Project.

Methods: The weed assessment focused on searches for existing weeds (mostly invasive alien[1]) that are most likely to cause ecological harm to native ecosystems, particularly those that can establish in primary forest, weeds that may potentially cause rehabilitation failure, and weeds not previously known to occur in the Papua New Guinea lowlands. The field component of the study involved the identification of weeds across a range of undisturbed and disturbed sites that were classified in three different priority classes (1 – 3), with Priority 1 being the highest priority requiring management and control. Disturbed sites were assessed to provide a representative characterization of sites that have facilitated weed invasion across the study area. The weed priority classes were developed by independent consultants (including the author of this report) to reflect the typical behavior of weeds in Papua New Guinea, based on field observations, and were used on the PNG LNG Project.

Results: The survey identified 101 species of weed, which included several native species with invasive characteristics. The most common weed life forms were herbs (34 species), grasses (23 species) and shrubs (17 species). Of the 101 species, seven are Priority 1 weeds which have the potential to cause ecosystem degradation by displacing native species, and may cause rehabilitation failure where rehabilitation is required. Thirty-six species are Priority 2 weeds and 58 species are Priority 3 weeds.

The Priority 1 species and their main occurrence were as follows:

- *Angelonia angustifolia* (Monkey face): A herb with infestations mostly on wellpads and associated landslips.
- *Cocus nucifera* (Coconut palm): A novel weed of undisturbed Mangroves (M) only.
- *Eichhornia crassipes* (Water hyacinth): An aquatic herb of waterbodies that was observed in the Purari River and its tributaries only.
- *Ludwigia leptocarpa* (Angelstem willow primrose): Infestations of this herb were mostly confined to disturbed waterlogged sites adjacent to logging roads and an area of forest that had extensive canopy dieback (i.e. dieback site, located southeast of Evara village within the export pipeline corridor) caused by severe flooding. Also present in ditches at the Purari airstrip.

[1] Alien is the term used in IFC PS 6 and refers to non-native, i.e. exotic species that may include accidental and intentional introductions of alien plants,

- *Mikania micrantha* (Mile a minute vine): A widespread vine of disturbed sites, but infestations restricted to disturbed sites with poor drainage and an undisturbed Swamp grassland (Gsw). Present around Project infrastructure.
- *Piper aduncum* (Bamboo daka): A shrub/small tree that can invade and degrade disturbed and primary forest. Common along disturbed road margins and present around Project Infrastructure.
- *Spathodea campanulate* (African tulip tree): A large tree confined to Muro Mission grounds. Can invade disturbed forest.

Despite the widespread distribution of weeds across the study area, most weed species will only persist in disturbed environments and will not invade undisturbed forest or other native vegetation formations apart from the Priority 1 species. However, where disturbances occur in locations that are required to be rehabilitated back to their pre-disturbance state, many of the weed species have the potential to inhibit rehabilitation without intervention.

GLOSSARY AND ABBREVIATIONS

Term	Definition
asl	above sea level
cm	centimetre
e.g.	for example
et al.	and others
FIMS	Forest Inventory Mapping System
i.e.	that is
km	kilometer
m	meter
PNG	Papua New Guinea
PRL	Petroleum Retention Licence
sp.	species (singular)
spp.	species (plural)

1 INTRODUCTION

1.1 PROJECT OVERVIEW

The following Project description is focused on the upstream components of the Papua LNG Project and aims at providing minimal but appropriate context for the baseline reports.

Joint venture partners are currently planning the development of the Elk-Antelope gas field, which is located within Petroleum Retention License 15 (PRL-15) in the Gulf Province, Papua New Guinea. Total E&P PNG Limited (TEP PNG), a wholly owned subsidiary of TOTAL S.A (TOTAL) has the largest interest in the Elk-Antelope gas field and is the operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

The Elk-Antelope gas field is a significant gas discovery in Papua New Guinea consisting of a gas reservoir with several trillion cubic feet of gas reserves located approximately 120 km inland from the township of Kerema, and 340 km northwest of Port Moresby.

The Project will comprise upstream production well development and associated infrastructure at the gas field within PRL-15, construction of an upstream central processing facility (CPF) and delivery of gas and condensate via onshore and offshore export pipelines to a LNG Plant site at Caution Bay, Central Province, 20 km northwest of Port Moresby. The design life for the Project will be 25 years.

- The Project area comprises the physical footprint of the various Project components and associated infrastructure as detailed below.Production, processing and related facilities (within PRL-15):
  - Wellpads and the associated gathering system (including flowlines and trunkline).
  - CPF.
  - Logistics base and river offloading facilities, accommodation camps, airstrip, roads and bridges.
  - Quarries, communications infrastructure.
  - Initial section of the onshore export pipeline.
- Onshore pipeline (outside PRL-15):
  - Remainder of the onshore export pipeline to landfall on the Gulf coast including valve stations.
  - Temporary laydown areas and camps.
  - Quarries, communications infrastructure.
- Transport (river) corridors:
  - River transport routes — the Purari, Urika-Ivo and Wame-Varoi rivers.
- Offshore pipeline:
  - Offshore section of the export pipeline to a LNG Plant site, Caution Bay.

As part of the Project environmental, social and health impact assessment (ESHIA), a terrestrial biodiversity baseline study has been commissioned to provide a baseline characterization of terrestrial biodiversity and conservation values present in the vicinity of the upstream Project area. This report presents the results of the technical study on weeds conducted as part of the terrestrial biodiversity baseline study. Description of vegetation communities and an inventory of flora are reported separately (Rogers, 2017, Venter, 2017). Applicable regulatory framework and standards are summarised in Appendix A.

2 UPSTREAM TERRESTRIAL BIODIVERSITY STUDY AREA AND ECOLOGICAL ZONES

The upstream terrestrial biodiversity study area (hereafter 'study area') covers approximately 7,290 km^2 of the Gulf Province lowlands (to c. 600 m above sea level (asl)). The study area is divided into five ecological zones, each of which is expected to support a distinct assemblage of terrestrial biota.

The study area encompasses the upstream project area of influence (Upstream PAOI), the area within which the Project may potentially and measurably impact biodiversity. The terrestrial biodiversity field surveys were focused at representative sites within the Upstream PAOI, hereafter referred to in this report as survey sites. Further description of the PAOI is provided in the main Upstream ESBS report and is no longer referred to in this report.[2]

The study area and its component ecological zones are shown in Figure 1. They are described in more detail in the Upstream Terrestrial Biodiversity Baseline Report.

2.1 STUDY AND OBJECTIVES

The purpose of the weeds technical study report is to assess the presence and status of non-native (i.e. exotic) weeds present within the study. The specific objectives of the study are:

- To identify the priority weeds across a range of representative disturbed and undisturbed sites within the study area including:
  - Existing project related infrastructure sites and associated roads.
  - Logging roads.
  - Villages and associated footpaths and gardens.
  - Biodiversity field sites.
  - Opportunistic observations.
- To provide an assessment of weed status across the study area based on weed invasion characteristics across the representative sites.

[2] The boundary of the PAOI is shown in figures for context only.

3 PRIOR STUDIES WITHIN THE STUDY AREA

Previous studies on vegetation in the study area focused on the upper Purari where detailed environmental baseline studies were undertaken as part of the Wabo Hydroelectric Scheme engineering feasibility studies for a proposed dam on the river in the early 1970s, however there are no record of weed studies available from the project. A similar investigation was undertaken in 2012 as part of the EIS for the Purari River Hydroelectric project. Unfortunately, the technical reports from the 2012 study are commercial in confidence and are therefore not available. Flora studies were undertaken for the InterOil EIS in 2010 (Douglas, 2010, Douglas and Warakai, 2010) which included weed surveys. The InterOil studies identified nine species of exotic weeds which are listed in Table 3-1, of which the small tree/shrub *Piper aduncum* is the most serious weed because of its ability to invade forest (Rogers and Hartemink, 2000).

Table 3-1 Weeds identified for the InterOil EIS

Species	Life form
Samanea saman	Tree
Piper aduncum	Small tree/shrub
Calliandra surinamensis	Shrub
Senna alata	Shrub
Ageratum conyzoides	Herb
Ludwigia hyssopifolia	Herb
Physalis minima	Herb
Vernonia lanceolata	Herb
Passiflora sp.	Vine

4 METHODS

4.1 WEEDS

The weed assessment focused on searches for existing weeds (mostly invasive alien) that are most likely to cause ecological harm to native ecosystems, particularly those that can establish in primary forest, species that may potentially cause rehabilitation failure, and weeds not previously known to occur in the Papua New Guinea lowlands. This focus is consistent with the International Finance Commission (IFC) Performance Standard 6 (PS 6) *invasive alien species* requirement for proposed projects where weeds are already established in the region. (The client is required to take measures to eradicate such species from the natural habitats over which they have management control).

Targeted field based searches for weeds were undertaken at a range of disturbed and undisturbed sites as follows:

- At twelve infrastructure sites (e.g., Herd base, well pads, access roads etc.) including the recently constructed Antelope 7 access road.
- At the nine biodiversity sites.
- At Purari airstrip.
- Along logging roads.
- In eight villages (Avavu, Herekela, Iuku, Kavavu, Muro Mission, Paevara, Poroi 2, Wabo) and Wabo Station, including associated footpaths and adjacent gardens.

Other sites were assessed opportunistically during other vegetation related surveys. These include:

- A forest dieback site where canopy collapse had occurred because of flooding, probably associated with the 2014 floods.
- Three villages (Kapuna, Evara and Kairu'u).
- The banks of the Purari River, Nea Creek and Kapuna boat wharf.

All the sites were located within PRL-15 and the export pipeline corridor except for Wabo, Wabo Station, Poroi 2, a logging road near Aivai village, mangroves in the Purari delta and some sections of the Purari River. Observation of weeds along the Purari River were made opportunistically throughout its course and reflect the riparian zone where hill forest, alluvial forest and Swamp woodland (Wsw) occur adjacent to the river. A summary of the weed survey sites, vegetation type and ecological zone in which the assessment was undertaken is provided in Table 4-1. Weed survey locations are mapped in Figure 1.

The disturbed sites represent typical habitats for weed colonization associated with existing infrastructure that the Project is likely to build. Villages (and associated footpaths) were also assessed to identify ornamental plants that have the potential to disperse or have dispersed to the wider landscape as a weed.

For each site targeted searches were undertaken for Priority 1 weeds which are the weeds most likely to cause ecological harm and degrade biodiversity values (see below), rather than a complete inventory of weeds at each site. Weed lists for each site were only compiled where time allowed and each weed recorded was assigned to one of three weed priority classes. The priority classes have been used on several projects in Papua New Guinea since 2009 when they were first used on the PNG LNG Project. The priority classes were developed by consultants, including the author of this report from observations of weeds and their invasiveness in Papua New Guinea, particularly in relation to their invasiveness in primary forest and rehabilitation sites. However, a weeds priority class may differ amongst environments and cannot be predicted for all potential disturbances that the Project may cause.

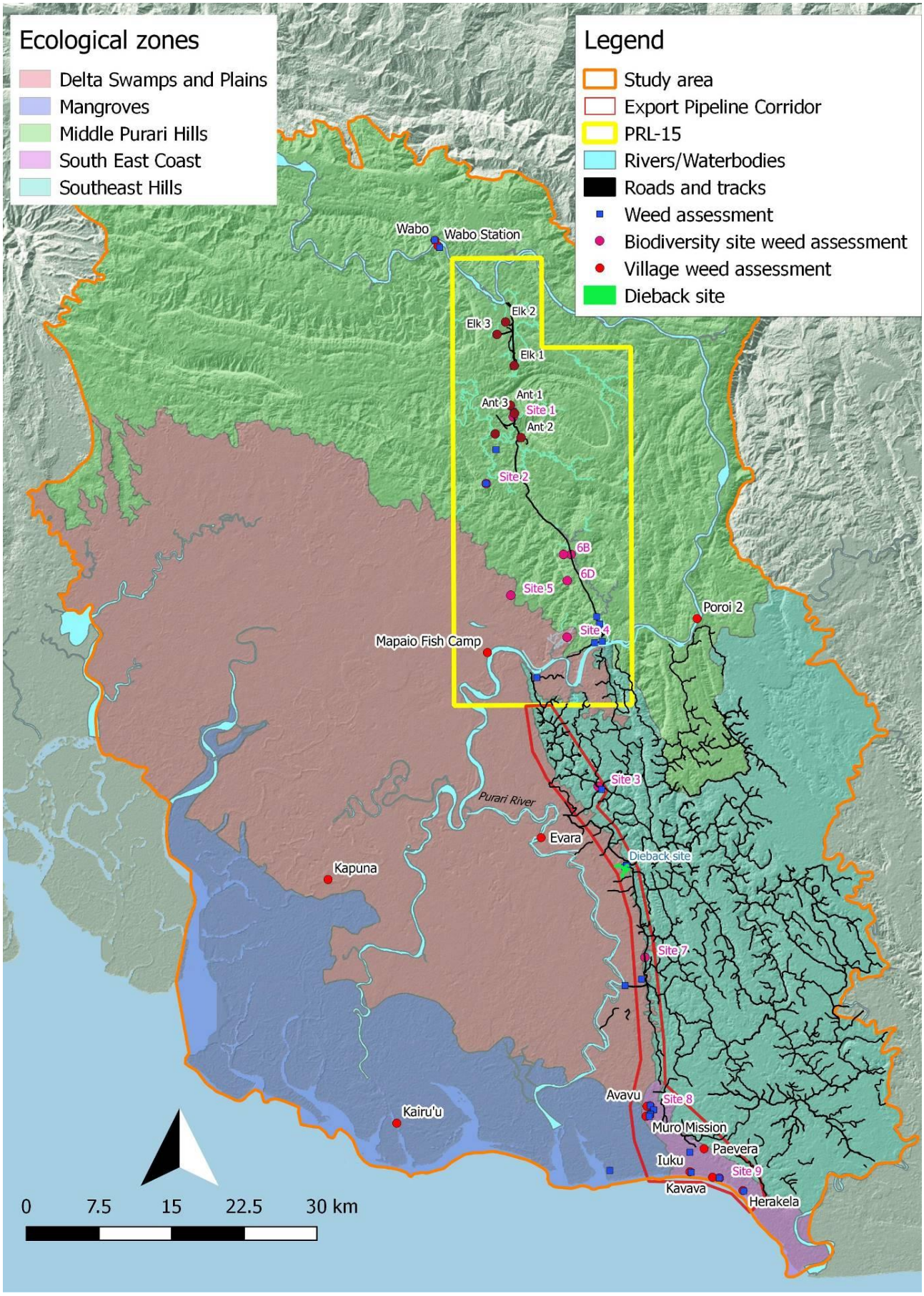
Weed species were identified in the field based on their visual characteristics, however where there was no fertile material (flowers or fruit) in some instances a weed was identified to genus level only.

Table 4-1 Weed survey locations

Location	Survey area description	Date of original disturbance	FIMS	Ecological Zone
Facilities				
Herd Base	Accommodation camp, adjacent areas and the small passenger boat wharf	Not known	Land use (O)	Middle Purari Hills
Herd Base access road/Kuku Creek road	Roadside, clearing and cuttings	Not known	Hill forest (Hm)	Middle Purari Hills
Antelope 7 access road	Access track between Ant 3 Operations Camp and Antelope 7 wellsite.	2016	Hill forest (Hm)	Middle Purari Hills
Wabo Station, road and boat landing	Station grounds, road from the airport terminal to the small boat landing and the small boat landing	Not known	Land use (O)	Middle Purari Hills
Kuku Creek Road (near Site 6)	Roadside clearings	Not known	Hill forest (Hm)	Middle Purari Hills
Purari airstrip	Margins of airstrip where regeneration is present and ditches near terminal building	Not known	Land use (O)	Delta swamps and plains
Wabo terminal building garden	Grounds of the Wabo terminal	Not known	Land use (O)	Middle Purari Hills
Wellpads				
Antelope 1	Wellpad clearing and sidecast slopes	2007	Hill forest (Hm)	Middle Purari Hills
Antelope 2	Wellpad clearing and sidecast slopes	2007	Hill forest (Hm)	Middle Purari Hills
Antelope 3 (Site 1)	Wellpad clearing and sidecast slopes	2007	Hill forest (Hm)	Middle Purari Hills
Elk 1	Wellpad clearing	2006	Hill forest (Hm)	Middle Purari Hills
Elk 2	Borrow mound sites across wellpad	2006	Hill forest (Hm)	Middle Purari Hills
Biodiversity survey sites				
Site 1 (Antelope 3 operations base)	Biodiversity field survey tracks within forest	Not applicable	Hill forest (Hm)	Middle Purari Hills
Site 2	Biodiversity field survey tracks within forest	2016	Hill forest (Hm)	Middle Purari Hills
Site 3	Biodiversity field survey tracks, logging roads and log skidding tracks	2006	Hill forest (Hm)	Southeast Hills
Site 4	Biodiversity field survey tracks	2016	Alluvial forest	Delta swamps and plains
Site 5	Biodiversity field survey tracks	Not applicable	Open alluvial forest (O), Swamp forest (Fsw) and Hill forest (Hm)	Delta swamps and plains/Middle Purari Hills
Site 6A, 6B, 6D – Kuku Creek Road	Biodiversity field survey tracks along road	Not known	6A & B: Road through Hill forest (Hm) 6D: Hill forest (Hm) ridgeline	Middle Purari Hills

Location	Survey area description	Date of original disturbance	FIMS	Ecological Zone
Site 7	Biodiversity field survey tracks	Not applicable	Swamp woodland/Swamp grassland (Wsw/Gsw), Open alluvial forest (Po) and Hill forest (Hm)	Delta swamps and plains/Southeast Hills
Site 8	Biodiversity field survey tracks	Not applicable	Swamp forest/Swamp woodland (Fsw/Wsw), Alluvial forest Pl, Small crowned hill forest (Hs) and Mangroves (M)	Delta swamps and plains/Southeast Hills
Site 9	Biodiversity field survey tracks	Not applicable	Small crowned hill forest (Hs), Alluvial forest (PI), Open alluvial Forest (Po) and Mangroves (M)	Delta swamps and plains
Villages				
Avavu, Herekela, Iuku, Kavavu, Paevara, Poroi 2, Wabo & Wabo Station.	Villages, tracks and gardens if visited. Wabo Station road.	Not applicable	Land use (O) across hills and alluvial plains, Small crowned hill forest (Hs) - disturbed	
Riparian/Wetland				
Purari River, Nea Creek (Mapaia fish camp), Kapuna and Oxbow (aerial only)	Banks of the Purari River and Nea Creek which flows from the Oxbow wetland to the Purari River. Aerial observations of the Oxbow wetland	Not applicable	Riparian zone	Delta swamps and plains
Logging Roads				
Aivai	Abandoned logging road on east bank of Purari opposite Aivai village. Site known as Aivai koki	Not known	Logging road through alluvial forest	Delta swamps and plains
Site 3	Logging road and skid tracks. Active road leading to Evara logging camp	Not known	Logging road through Hill forest (Hm)	Southeast hills
Logging roads near dieback site	Abandoned logging roads including log landings (log storage areas) across previous hill forest and alluvial forest sites	Not known	Logging road through Hill forest (Hm) and through Open alluvial forest (Po)	Delta swamps and plains/Southeast hills
Near Purari strip	Along logging road and margins covering undulating terrain including wet sites and dry sites on moderate slopes	Not known	Hill forest (Hm)	Southeast hills
Site 7. Logging road through camp	Abandoned logging road	Not known	Logging road through Open alluvial forest (Po)	Delta swamps and plains
Dieback				
Forest dieback site	Alluvial forest subject to extensive forest dieback and logging in places	Not known	Open alluvial forest (Po)	Delta swamps and plains

Figure 1 Weed survey locations



Priority 1

Priority 1 species are all known weeds that can persist in unmodified native ecosystems and or seriously negatively impact on regeneration/rehabilitation measures. In forests, they have the potential to invade natural gaps or establish along stream banks, particularly on silt deposited after flooding. In wetlands, they can clog slow flowing drainage channels and water bodies, and may dominate riparian sites. Their seeds have typical longevity of several years, and they may also establish by asexual means (e.g. above ground runners, below ground tubers and suckers). Soil seed bank stores allow for outward invasion into larger natural disturbances. Flood events can facilitate their asexual spread into new sites as segments are broken off and lodge in new downstream sites. Priority 1 species may be able to arrest natural regeneration in gaps, establish on landslides and move into other forest gaps as these become available, out-competing native species.

Priority 2

Priority 2 species are those weeds that can persist in disturbed areas. Their persistence is dependent on an ongoing level of disturbance that is generally associated with anthropogenic disturbance. Priority 2 species are more reliant on people for dispersal and establishment, and are unlikely to persist without some anthropogenic influence.

Priority 3

Priority 3 species require ongoing disturbance and generally full sun for persistence. They are unable to out-compete native species without regular human interference. These species are not considered an ecological threat, but should be controlled where they occur in conjunction with Priority 1 and Priority 2 weeds where they inhibit rehabilitation.

4.2 VEGETATION TERMINOLOGY

Vegetation types are referred to in the text using a set of Forest Inventory Mapping System (FIMS) - equivalent terms developed specifically for the upstream terrestrial biodiversity baseline study (Appendix B). These closely follow the formal FIMS descriptors, which are based on the founding vegetation descriptions (Hammermaster and Saunders, 1995, Paijmans, 1976), but are less cumbersome and have been ground-truthed at the terrestrial biodiversity survey sites and reviewed more broadly by aerial survey.

Where a specific vegetation type is referred to in the text it is capitalized and followed in brackets by its FIMS code. In this way reference is made to vegetation mapping units present in surveyed areas, for example 'Hill forest (Hm)' and 'Open alluvial forest/Swamp forest (Po/Fsw)'.

Where more general reference is made to broader vegetation types that include multiple possible variants within the study area (and more widely in Papua New Guinea) it appears without capitals or a FIMS code, for example 'hill forest' and 'alluvial forest'. These generic types closely follow the various basal FIMS vegetation types, which in these examples are coded 'H' and 'P' respectively.

A full list of FIMS vegetation types present within the study area, and equivalent terms used in the Biodiversity Study, is presented in the Upstream Terrestrial Biodiversity Baseline Report.

5 RESULTS

5.1 WEEDS

The survey identified 101 species of weed (Appendix C), which included several native species with invasive characteristics. The native species included the vines *Merremia peltata*, *Ipomea aquatica* and *Pueraria montana*, and the grasses *Imperata cylindrica* (kunai), *Saccharum spontaneum*, *Ischaemum polystachum* and *Ischaemum muticum*. The most common weed life forms were herbs (34 species), grasses (23 species) and shrubs (17 species). Of the 101 species, seven species are Priority 1 species which have the potential to cause ecosystem degradation by displacing native species, and may impact rehabilitation success where rehabilitation is required. Thirty-six species are Priority 2 species and 58 species are Priority 3 species. A summary of the weed life forms by priority class is provided in Table 5-1.

Table 5-1 Summary of recorded weed priorities by lifeform

Lifeform/Priority	1	2	3	Total
Fern		1	2	3
Grass		8	15	23
Herb	3	11	20	34
Palm	1			1
Sedge			6	6
Shrub		7	10	17
Tree	2	1	1	4
Vine	1	8	4	13
Total	**7**	**36**	**58**	**101**

5.1.1 Weed communities

Most of the disturbed sites assessed for weeds were dominated by herbs (34 species), grasses (23 species), shrubs (17 species) and sedges (6 species). Herbs were mostly from the Asteraceae (daisy) family which included nine species of annual weeds and one vine, *Mikania micrantha* (Mile a minute vine). Weeds from the Asteraceae typically colonize exposed soil surfaces, grow quickly and produce abundant wind dispersed seed that float across the landscape in thermal air currents. Most of the herbs were Priority 3 species but three Priority 1 species were present which included *Angelonia angustifolia* (Monkey face), *Ludwigia leptocarpa* (Angelstem willow) and *Eichhornia crassipes* (Water hyacinth) which was confined to wetlands and slow moving water. This species occurred from the oxbow wetland to Kapuna and was also noted at Kairu'u village near the coast, 24 km to the west of the proposed export pipeline corridor. The vine *Mikania micrantha* can also exhibit Priority 1 characteristics, but only in poorly drained sites and particularly after a natural disturbance such as flooding that causes tree death, allowing sufficient light for it to grow quickly and climb over the canopy of regenerating forest. The characteristics of these species is discussed in Section 7.

Grasses were common since they are fast growing and can reproduce rapidly from wind dispersed seed, and asexually via runners and underground rhizomes. Moreover, the large number of exotic grass species in Papua New Guinea ensures that most habitats are suitable for at least one of the grass species. Only one species, *Pennisetum purpureum* is a potential Priority 1 species because of its potential to inhibit natural regeneration across disturbed sites.

Trees and shrubs accounted for four and 17 species respectively, of which two are Priority 1 species. *Piper aduncum* (Bamboo daka) is a highly invasive shrub to small tree, which has caused substantial degradation in disturbed forests throughout Papua New Guinea by competing-out native species (Rogers and Hartemink, 2000). It invades undisturbed forest when seed is transported along creeks where it can establish on fresh silt deposits. It was common along existing roads in PRL-15, logging roads (Plate 1) and along the margins of the Purari airstrip.

The only Priority 1 species that is a large tree is *Spathodea campanulate* (African tulip tree) (Plate 2) which was identified along the boundary of the school playing field at Muro Mission. This species has caused severe forest degradation on the Gazelle Peninsula of East New Britain where it has invaded remnant forest disturbed by logging. It was originally introduced to East New Britain as an ornamental

in the 1940s (Peekel, 1984), but has since become, together with *Piper aduncum* the most successful woody invader of secondary forests in northern New Guinea lowlands and the adjacent Bismarck Archipelago (Bito, 2007). The species was not previously known to occur in Gulf Province, and Bito (2007) suggests it does not occur south of the Sepik River, however this is incorrect since it was observed at Oomsis near Lae in Morobe Province in 1997 (Pers. Obs. Howard Rogers). The identification of the species in the study area may represent a new range extension record for this invasive species.

Sedges were a distinctive feature of the weed communities on wellpads, and were often common where drainage was impeded. Poor drainage is often the result of soil compaction along roadsides and across wellpads. Wellpads typically have flat surfaces with shallow depressions and poor run off providing favorable habitat for sedge species. Once established sedges are often persistent due to the presence of underground tubers, however no sedges are Priority 1 species.

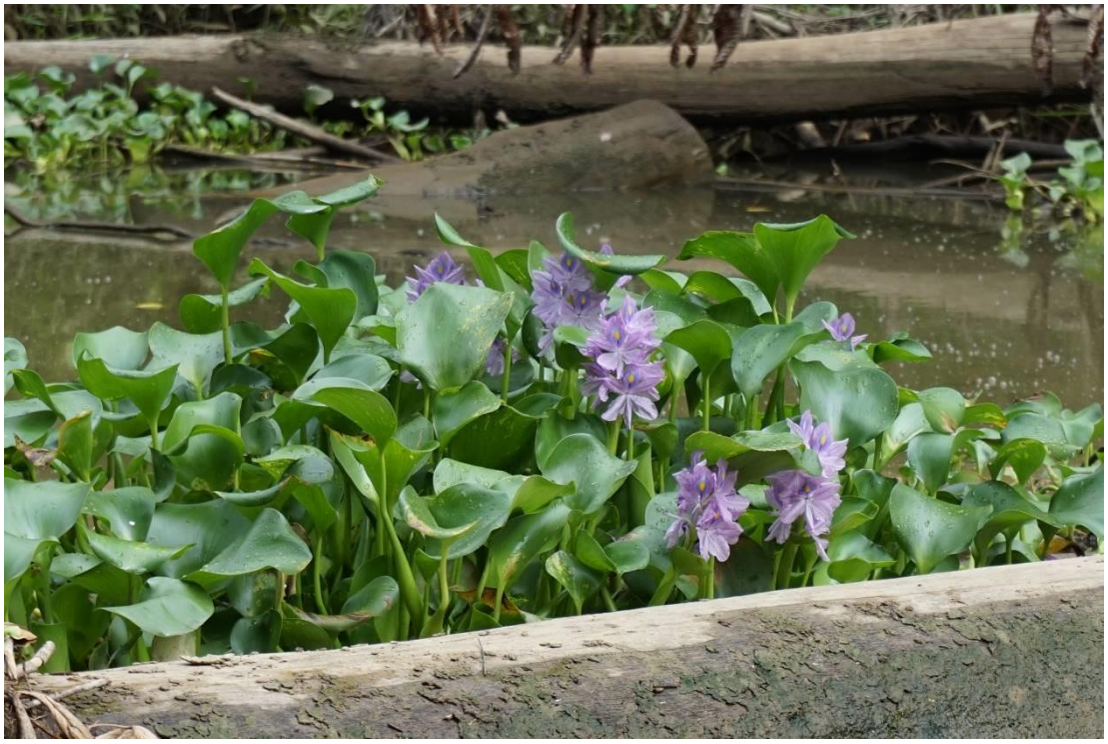
Plate 1 Infestation of the shrub *Piper aduncum* along a logging road

A distinctive feature of the weed communities were several species of vine, some of which can climb over tall trees or smother regeneration of native tree species. Notable vines included the native vine *Merremia peltata* and the exotic *Mikania micrantha*. Infestations of *Merremia peltata* were common along logging roads, particularly where poorly drained in full sun. *Mikania micrantha* occurred along most of the logging roads and tracks investigated but was also present in an undisturbed Swamp grassland (Gsw) near Site 7. Infestations were confined to poorly drained sites.

Two important floating aquatic weeds were present. The highly invasive *Eichhornia crassipes* (Water hyacinth) (Plate 3) and *Ipomea aquatica*. *Eichornia crassipes* was abundant in slow moving waterbodies including the oxbow wetland and Herbaceous swamps (Hsw) at Kapuna. It was also found in the lower reaches of the Purari River south of Aivai, and in slow moving tidal creeks at Akoma/Kairu'u near the coast. *Ipomea aquatica* occurred throughout the oxbow wetland along the margins of the main wetland, along Nea Creek and in terrestrial habitats. In terrestrial habitats, it provides a relatively sparse ground cover in association with other weeds. Notable occurrences included the logging road near the dieback site and the abandoned log landing opposite Aivai. *Ipomea aquatica* is a native species but has the potential to inhibit rehabilitation of riparian sites.

Plate 2 ***Spathodea campanulata*** **(African tulip tree)**

Plate 3 ***Eichhornia crassipes*** **(Water hyacinth)**



5.1.2 Terrestrial biodiversity survey sites

The terrestrial biodiversity survey sites that were located in undisturbed forest/vegetation were predominantly free of weeds reflecting their remoteness from anthropogenic disturbance and weed vectors, these included sites 2, 4, 5, 7 (away from the logging road) and 9 (mangrove component). The only exceptions to this was the oxbow wetland, an area of Mangroves (M) and a Swamp grassland (Gsw). For these three sites moving water had facilitated the establishment of Water hyacinth, Coconut palms (*Cocus nucifera*) and Mile a minute vine (*Mikania micrantha*) respectively. Forested areas of the terrestrial biodiversity survey sites that had been subject to disturbance from logging or village activities (hunting footpaths, small scale clearance for food gardens and harvesting of bush materials) were subject to relatively minor weed invasion where disturbed. These include Site 3, forest edges adjacent to the logging road through Site 7, Site 8 and Site 9. A summary of the notable weeds at the terrestrial biodiversity survey sites is provided here:

- At Site 7 the vine *Mikania micrantha* (Mile a minute vine) had infested a Swamp grassland (Gsw) dominated by the tall native grass *Saccharum spontaneum*. This site was located approximately 800 m from a major logging road where the same species was common. Flooding may have deposited parts of the plant within the Swamp grassland (Gsw) which can reproduce asexually.
- Mangroves, 6 km to the west of the coastal village Harevavu have been colonized by *Cocus nucifera* (Coconut palm) in places which at the location assessed had formed localized infestations (Plate 4). Coconuts appear to have floated in along the channels during flood events and subsequently germinated on raised microsites, possibly crab mounds. There is a plentiful supply of coconuts from the plantations along the Orokolo coast.
- The floating aquatic weed *Eichhornia crassipes* (Water hyacinth) was present in patches across the oxbow wetland. The margins of the oxbow wetland were also dominated by *Ipomea aquatica* where it appeared to be partially clogging the wetland, however this is a native species that appears to invade wetlands as they become silted (a natural process for oxbow lakes).
- At sites 7 and 9 the exotic Bilimbi tree (*Averrhoea bilimbi*) had invaded forest along footpaths in otherwise undisturbed forest. The Bilimbi tree is not a common weed species, however it may have spread from villages and gardens since it is planted for its fruit and is not native to Papua New Guinea.
- At sites 1 and 8 the shade tolerant shrub Koster's curse (*Clidemia hirta*) was identified. This species can form localized infestations. The species is regarded as naturalized in PNG (Smith, 2011).

Plate 4 Coconut palms regenerating in mangroves

5.1.3 Accommodation camps

Existing infrastructure camps (Herd Base, Antelope 3 and Wabo) provide a range of habitats for weeds including drainage channels, unmowed grassy sites, exposed soils from earthworks and roadsides. In addition, some ornamental plants that have been planted in the camps appear to have spread along roads and into the wider landscape, including wellpads, forming localized small and large scale infestations. The infrastructure camps provide a variety of surfaces/habitats for weed establishment, including gravel surfaces, exposed topsoil and drainage channel banks, but with grasses, sedge species and herbs being the most common. However, most of the weeds are common throughout Papua New Guinea and the tropics and have been in Papua New Guinea for decades or longer (Henty and Pritchard, 1988).

The main exception to this was the presence of the ornamental snapdragon flower *Angelonia angustifolia*. This plant has been planted as an ornamental within the camps and has spread widely along the roads in the Antelope 3 area and across some of the wellpads, e.g. Elk 1. In addition, the herbaceous *Plectranthus scutellarioides* which is planted as an ornamental at the now decommissioned Antelope 3 accommodation camp (Site 1 locality) has spread widely across infrastructure sites. Another ornamental herb *Celosia argentia* was also present in a planting box at this location. This species was not observed in the wider landscape but can infest gravelly drainage lines in full sun. The location of Herd Base and Antelope 3 are provided in Figure 1.

Woody weeds are usually uncommon in camp environments due to regular mowing and slashing of vegetation however, there was one exception to this. The Priority 1 weed *Piper aduncum* was identified at Herd Base close to the small boat wharf and around the camp. It also appears to have been planted at Wabo Station just outside the accommodation camp security fence.

Plate 5 *Celosia argentia* at the Antelope 3 accommodation camp

5.1.4 Wellpads

Wellpad surfaces provide a relatively uniform habitat for weeds that is characterized by flat compacted surfaces, with shallow soils and little microtopography, resulting in a predominantly poorly drained habitat. Despite the uniformity thirty-five species of weed were identified across these sites.

The most common and widespread weed was the grass *Paspalum conjugatum*, but with large infestation of the herbs *Angelonia angustifolia* and *Veronia cinerea* in places, particularly across

Antelope 1 and Elk 1. *Angelonia angustifolia* (Plate 6) may have been planted around temporary camps on the wellpads since the food plant Aibika (*Hibiscus manihot*) was also present at Elk 1. In addition, *Plectranthus scutellarioides* which is planted as an ornamental at the Antelope 3 accommodation camp, was present across several wellpads with several small infestations.

Some of the wellpads also have small wetlands that have formed in holding ponds which are favored by the herbs *Ludwigia octovalis*, *Bacopo procumbens* and a range of sedges.

Plate 6 Infestation of *Angelonia angustifolia* at Elk 1

5.1.5 Airstrips and terminals

The Purari airstrip supports at least 66 species of weeds which is approximately two thirds of all the weed species recorded across the study area. The margins of the airstrip were infested with *Piper aduncum*, which in places had almost formed monospecific stands. The airstrip is also connected to an abandoned logging road providing a corridor for weed invasion.

The Wabo airport terminal was the only location where the Priority 2 annual twining vine *Ipomea quamoclit* was present. This species is usually planted as an ornamental.

5.1.6 Roads

Roadside sites investigated included the Kuku Creek road from Herd Base to Antelope 3, the access track to Antelope 7 within PRL-15, and abandoned logging roads to the south of the Purari River. Roadsides provided habitat for at least 30 species of weed which included all the common weed plant lifeforms. Many of the species identified along the roadsides also occur across other types of disturbed habitat. However, along the Herd Base access road a range of Priority 1 weeds occurred including the vines *Mikania micrantha* and *Pueraria phaseoloides*, the tall grass *Pennisetum purpureum* and the small tree/shrub *Piper aduncum*. Observations during field assessment along the road near Herd Base, Kuku Creek and near the Antelope 3 camp suggest similar weed species occur throughout the length of the road.

Other common weed species included the invasive vine *Pueraria phaseoloides*, a range of shrubs including the sensitive plants *Mimosa diplotricha* and *Mimosa pudicaica*, the shrubs *Aeschynomeme americana* and *Aeschynomene indica* which can form localized infestations (Plate 7), and the small tree/shrub *Piper aduncum*. The native vine *Meremmia peltata* had also infested most of the logging roads, particularly those that had not been used for several years. Infestations were more severe where drainage was poor.

The Antelope 7 access road, which was constructed in 2016 was just beginning to be colonized by weed species (grasses only) in September 2016, the seed of which had probably been transported on contaminated machinery that may not been properly washed down. The grass weed species included *Paspalum conjugatum* and *Urochloa mutica* (Para grass).

Roadside weed communities are likely to revert to communities dominated by native trees provided they are not redisturbed, however where aggressive fast growing invasive vines are present the roadside and adjacent forest can become completely covered by a tangled mat of vines (Plate 8). Roadsides are initially colonized by a range of grass species and herbs with woody plants (trees and shrubs) colonizing at a later stage. Adjacent ditches are typically colonized by a different suite of species including sedges and Ludwigia spp., and in places the highly invasive Priority 1 herb *Ludwigia leptocarpa,* which was identified in ditches adjacent to the logging road through Site 7.

Plate 7 An infestation of the shrub *Aeschynomeme indica*

Plate 8 The vine *Pueraria phaseoloides* climbing over the canopy of small trees

5.1.7 Villages, gardens and footpaths

Villages often support a range of weed species some of which are planted as ornamentals, medicinal plants or as hedges and shade trees. Ornamental weeds included the shrub *Clerodendron paniculatum*, the vine *Ipomea quamocit*, the tall sunflower like herb *Tithonia diversifolia*, the scrambling yellow flowered vine *Allamanda cathartica* and the red flowered tall herb *Canna indica*. The small tree/shrub *Piper aduncum* had also been planted for fencing, shade and medicinal uses.

Disturbed land around villages provided habitat for many common tropical weed species including many grasses, herbs from the Asteraceae family and some vines, of which the most significant was *Mikania micrantha*. This fast-growing twinning vine can cause problems in wetter sites where it will rapidly grow and cover small to medium sized trees, and garden crops such as bananas. At Evara village, community members stated that the vine is regularly removed from banana plants and was not present until forest nearby was logged. The plant may have spread via seed attached to logging trucks, but can also spread asexually via plant fragments.

Garden areas which occur adjacent to villages and along the river banks of the Purari River and its tributaries support a range of annual weeds which are mostly of nuisance value such as the herb *Bidens pilosa*, the seeds of which stick to animal fur and clothes enabling it to spread widely across disturbed sites.

5.1.8 Dieback site

The dieback site is an area of Open alluvial forest (Po) that appears to have been impacted by the extreme flood event in 2014, causing canopy dieback and tree mortality. It has also been logged. This site was infested with the tall herb *Ludwigia leptocarpa* which is a Priority 1 species. The site was partly waterlogged which is the favored habitat of this species provided plants are growing in full sun conditions, as was present in logged areas and where trees had died (Plate 9).

Plate 9 *Ludwigia leptocarpa* (Anglestem willow primrose) infestation

In addition to these Priority 1 weeds two other weeds have the potential to be Priority 1 species due to their potential impact on rehabilitation. The tall grass *Pennisetum purpureum* can dominate disturbed locations in full sun, particularly along roadsides, and the vine *Pueraria phaseoloides* can infest areas of natural regeneration by scrambling over vegetation reducing growth and potentially causing plant mortality. These species are currently classified as Priority 2.

5.2 WEED DISPERSAL

Throughout the study area disturbed surfaces provide a range of habitats for weed colonization and establishment. The weeds are typically transported into newly disturbed locations by a range of vectors including:

- Machinery and equipment that have soil attached that is contaminated with seeds.
- People with seeds attached to clothing or contaminated soil on footwear.
- Wind dispersed seed, particularly grasses and herbs from the Asteraceae family, along newly opened corridors such as roads.
- Animal dispersed seed by birds, bats and non-volant mammals.
- Seed attached to fur of native wildlife and domestic animals.
- Flooding events that transport seed and plant fragments across alluvial environments.
- Intentional planting of ornamental plants with invasive properties, facilitating dispersal across disturbed environments.
- Intentional transplanting of food crops with contaminated soil attached.

These dispersal mechanisms result in an ongoing seed source that typically increases in abundance and frequency as the area of recently disturbed surfaces increases.

6 STATUS OF WEEDS IN THE STUDY AREA

This section provides a summary of the status of weeds in the study area based on the characterization of representative sites and observations made during aerial survey. Since weeds are widely dispersed across the study area where there has been anthropogenic disturbance, it is assumed that similar sites will have similar weed community characteristics, e.g., dominated by herbs, vines or grasses. Weed status is provided in Table 6-1.

Table 6-1 Weed status

Site type	Infestation level*	Comment	Weed community
Abandoned logging roads and petroleum industry access roads	High	Typically 100% ground cover of weeds unless on steep slope exposed to the sun	Nearly all weeds recorded occur along roads although grasses are less common other than at the margins. Priority 1 weed *Piper aduncum* common along road sections.
Well pads	High	Typically 100% ground cover of weeds unless no mineral soil. Where no mineral soil, e.g. stony and poorly drained typically covered in cryptogams[3]. Where no mineral soil and well drained no vegetation cover	Variable weed communities depending on the well pad drainage. Mostly herbs, grasses and sedge. Some dominated by the Priority 1 herb *Angelonia angustifolia*
Village walking tracks	Medium - High	Weeds persist on margins of walking tracks. Where in full sun weed ground cover is high	Mainly herbs, occasional vines including ornamental plants
Village gardens	Low - Medium	Variable weed cover depending on level of garden maintenance	Mostly annuals such as *Bidens pilosa* and *Ageratum conyzoides*
Logged over forest	Low	Occasional weeds only provided the canopy closes after logging	The fern *Lygodium microphyllum*, the small subshrub *Phyllanthus niruri*. Occasional grasses and herbs present
Undisturbed forest	Nil	-	No weeds recorded
Landslips in hill forest adjacent to the Purari River	Low - Medium	Bare soil subject to weed invasion	Grasses and herbs, the Priority 1 weed *Piper aduncum* and the prostrate shrub *Mimosa diplotricha*
Herbaceous swamps near logging roads	Medium	-	Only the vine *Mikania micrantha* was recorded
Lakes and slow moving waterbodies	Medium	Variable levels of aquatic weeds, but high along margins of the main oxbow lake	The herbaceous vine *Ipomea aquatica* and the herbaceous *Eichhornia crassipes*
Purari River banks and its tributaries	Nil - High	Where forested weed occurrence is rare. Where cleared weed banks are covered in grasses	Where riparian zone undisturbed very occasionally individual stems of the Priority 1 weed *Piper aduncum* and the shrub *Leucaena lecocephala*. Where banks cleared of forest grasses dominate, e.g. *Urochloa mutica. Ipomea aquatic* may also be present
Dieback sites (dieback associated with flood events)	High	Infestations of weeds that preferentially establish in poorly drained sites in areas where the forest canopy has	Infestations of the Priority 1 weed *Ludwigia leptocarpa*

[3] Plants that reproduce by spores, that is, without flowers or seeds (e.g. bryophytes, ferns and fungi).

Site type	Infestation level*	Comment	Weed community
		collapsed	
Mangroves	Low - Medium	Confined to mangrove forest on raised microsites	Groves of *Coconus nucifera* (Coconut palms) in places

*Infestation levels: High = Most of site covered by weeds, Medium = Patchy weeds with localised infestations, Low = Occasional weeds or occasional isolated patches with higher densities.

Based on the levels of weed invasion across representative sites the weed status of the study area is as follows:

- Undisturbed forest is weed free.
- Logged over forest has low levels of weed invasion that declines with canopy closure.
- All abandoned/unused roads and road margins are infested with weeds.
- Mangrove forest has been invaded by coconut palms in places where close to a tributary of the Purari River.
- The Purari River banks and its tributaries are mostly free of weeds apart from where forest has been cleared from the river banks.
- Wetlands have variable levels of infestation of the aquatic weeds, *Ipomea aquatica* and *Eichhornia crassipes*.
- Herbaceous swamps (Hsw) that are close to logging roads may have infestations of the vine *Mikania micrantha*.
- Villages, village tracks have localised infestations of weeds.
- Logged over alluvial forest that is subject to waterlogging and has been heavily logged or has dieback associated with waterlogging resulting in an open canopy is likely to be subject to invasion by the Priority 1 weed, the herb *Ludwigia leptocarpa*.

7 PRIORITY 1 WEED DESCRIPTIONS

This section describes each Priority 1 weed species, however other species may also show Priority 1 characteristics under certain conditions, particularly in large clearings where topsoil is exposed. However, it is not possible to predict which other species will show Priority 1 characteristics since several specific environmental conditions may be required before an individual weed becomes problematic (e.g., seed source, soil type, drainage conditions, type of disturbance and light levels). Similarly, the Priority 1 species listed in this section may not always display the invasiveness associated with a Priority 1 species if environmental conditions are not suitable. For example, the vine *Mikania micrantha* (Plate 10) is widespread in disturbed environments across the study area but only becomes highly invasive in disturbed wetland environments. Also, the coconut palm is only invasive in specific mangrove habitats where abundant seed source exists in the surrounding environment, and there are sufficient raised microsites to allow it to establish and grow.

Plate 10 Mikania micrantha infestation in a Swamp Grassland (Gsw)

7.1 *ANGELONIA ANGUSTIFOLIA* – MONKEY FACE

Habit: Perennial herb to 1.5 m.

Habitat: Open areas in full sun, particularly wellpads and roadsides to a lesser extent. Planted as an ornamental within camps.

Dispersal: Spread by seed and division of the root mass.

Impacts: Forms large infestations on wellpads and across slips on sidecast slopes off the wellpads. Potential to cause rehabilitation failure.

7.2 *COCUS NUCIFERA* – COCONUT PALM

Habit: Tall palm to 20 m.

Habitat: Coastal and inland lowlands.

Dispersal: Spread by floating seed in the ocean and tidal rivers. Also, planted as a subsistence crop and in plantations for copra production.

Impacts: Forms localized infestations in Mangroves (M) where sufficient raised microsites persist for establishment and ongoing growth. Causes structural change in mangrove forest and potential to out-compete native species.

7.3 *EICHHORNIA CRASSIPES* – WATER HYACINTH

Habit: An erect, perennial herb to 0.6 m height. Free-floating or occasionally rooted in shallow water.

Habitat: Prefers slow moving water such as lakes and lagoons. Can persist in permanently wet soils.

Dispersal: New plants are rapidly produced from stolons and from parts of the plant that break away or drift in floods. Seed is viable for up to 15 years.

Impacts: Forms thick mats on the water surface affecting aquatic habitat which may impact terrestrial fauna that feed on crustaceans and mollusks.

7.4 *LUDWIGIA LEPTOCARPA* – ANGELSTEM WILLOW PRIMROSE

Habit: Multi-stemmed shrub to 1 m height, but occasionally up to 3 m height.

Habitat: A plant of wet places, swamps and stream edges and roadside ditches.

Dispersal: Seeds in a capsule which can hold over 2000 seeds each. Capsules are provided with "floats", and so are water-dispersed. Seed is also dispersed by water birds. Plants are reproductive at 67 days (Oziegbe and Faluyi, 2012).

Impacts: Potential to form widespread infestations across reinstatement areas, particularly across swampy sites where it can form a dense monoculture inhibiting regeneration of native species. Potential to be highly invasive on wetland habitat margins.

7.5 *MIKANIA MICRANTHA* - MILE A MINUTE VINE

Habit: Fast-growing, climbing, twinning slender-stemmed perennial vine.

Habitat: Disturbed forest, stream banks and gardens.

Dispersal: Wind-blown seed and tiny stem fragments will take root rapidly to develop into new plants. Flooding can also assist in long range dispersal of seed.

Impacts: Can smother disturbed forest particularly swamp forest. Also, smothers garden plants such as bananas on wetter sites.

7.6 *PIPER ADUNCUM*

Habit: Small tree/shrub to 7 m tall, with short silt roots and soft, brittle wood; foliage and twigs aromatic. Branches erect, but with drooping twigs and swollen, purplish nodes.

Habitat: Disturbed forest, roadsides and gardens in lowlands and highlands. Can also establish in undisturbed forest in natural gaps and along river banks in freshly deposited sediment. Aggressive colonizer of clearings, particularly abandoned gardens where it can form a monoculture.

Dispersal: Individual fruiting spikes contain huge numbers of tiny seeds that are dispersed by birds and flying foxes (Lepš *et al.*, 2002). May be introduced into new areas on machinery, particularly logging and road making equipment. Locally, it spreads by suckers, forming large clumps.

Impacts: *Piper aduncum* grows to 7 m high, shading out or displacing crops and native vegetation. It grows extremely quickly, forms large clumps and can almost completely exclude native species forming a monoculture (Rogers and Hartemink, 2000). However, it is considered a naturalized plant in some villages where it is used for shade. It is also known for improving soil nutrient status in fallow periods for some crops (Hartemink, 2006). Where severe infestations occur close to villages it can have a significant impact on ecosystem services by competing out useful plants essential for local livelihoods (Siges *et al.*, 2005).

7.7 *SPATHODEA CAMPANULATA* – AFRICAN TULIP TREE

Habit: Large tree to 20 m tall. Distinctive orange-red flowers.

Habitat: Disturbed forest, roadsides and Muro Mission school grounds. Probably planted as an ornamental.

Dispersal: Mass production of wind dispersed seed. Also, persists by suckers if felled.

Impacts: Potential to infest disturbed forest remnants competing out native species. Has caused substantial degradation in remnant forests across the Gazelle Peninsula of East New Britain (Bito, 2007).

8 CONCLUSION

This study achieved its study objectives of the assessing the the presence and status of non-native (i.e. exotic) weeds present within the study area, based on field survey of a range of representative disturbed and undisturbed sites.

Weeds are distributed widely across the study area, many of which were probably first introduced into the area in coastal regions because of the Australian Administration attempts to promote economic activity in the area by encouraging white settlers to plant coconut plantations for copra production. Further weed invasion across the study area is likely to have been associated with the development of Wabo Station to serve the Purari Hydroelectric Scheme studies in the 1970s, followed by the development of corridors of weed invasion by the construction of logging roads and petroleum exploration access roads. Consequently, weeds are distributed throughout the study area from the coast to remote wellpads provided there has been anthropogenic disturbance.

Despite the widespread distribution of weeds across the study area, most weed species will only persist in disturbed environments and will not invade undisturbed forest or other native vegetation formations apart from two Priority 1 species; *Piper aduncum* which can invade forest and the vine *Mikania micrantha* which can invade Swamp grasslands (Gsw). Wetland ecosystems are also threatened by the Priority 1 aquatic weeds *Eichhornia crassipes* and *Ipomea aquatica* which can invade lakes and slow moving waterbodies impacting fauna habitat.

8.1 KEY FINDINGS

The key findings of the weed study are as follows:

- Seven Priority 1 weed species are established in the study area which will require management and control to mitigate impacts on forests and sites requiring rehabilitation post construction.
- The Priority 1 weed *Piper aduncum* which is the weed species most likely to cause severe ecological harm is present at existing Project infrastructure locations, including Herd Base, Wabo Camp and extensively along the margins of the Purari airstrip.
- The Priority 1 weed *Angelonia angustifolia* is still being planted as an ornamental at Herd Base and has been introduced and subsequently spread widely across some Project wellpads.
- The Priority 1 weed *Coconus nucifera* has established in undisturbed mangroves (M) in Orokolo Bay impacting the mangrove forest structure.
- Invasion and establishment of weeds across the study area has mostly been facilitated by infrastructure development, particularly roads which provide corridors of disturbed sites suitable for weed establishment and growth. The only exception to this is for the coconut palm (*Coconus nucifera*) which has spread from coconuts drifting through the waterways from old coconut plantations established along the coast.

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APPENDIX A – Regulatory Framework and Standards

REGULATORY FRAMEWORK AND STANDARDS

Regulatory frameworks relevant to the weeds study and the associated impact assessment component of the terrestrial biodiversity study and are outlined below. They include:

- Papua New Guinea legislative and regulatory requirements.
- International standards and guidelines.
- TEP PNG's corporate standards and guiding principles.

Papua New Guinea Authorities and Legislation

In accordance with Total's *Code of Conduct* (Section 2.3), the Project respects "all applicable national and international laws and norms".

The Conservation and Environment Protection Authority (CEPA), formerly the Department of Environment and Conservation (DEC), is the Government department responsible for protecting PNG's environment. Its two key functions, to conserve environmental values and to regulate development projects, are performed through a variety of legislative mechanisms.

The *Environment Act 2000* and supporting *Environment (Prescribed Activities) Regulation 2002* provide the legal framework for regulating the Project's environmental effects. Under these regulations, the Project has been classified as a Level 3 Activity, and in accordance with Section 50 of the *Environment Act* must submit an environmental impact statement (EIS). The terrestrial biodiversity baseline study has been undertaken with deference to the requirements of the *Environment* Act, and to its key objectives (outlined in Part 2, Section 4 of the Act), including:

- "Avoid, remedy or mitigate any adverse effects of activities on the environment by regulating activities, products, substances and services that cause environmental harm".
- "Apply a precautionary approach to the assessment of risk of environmental harm".

INTERNATIONAL STANDARDS AND GUIDELINES

The following international standards and guidelines are relevant to terrestrial biodiversity under Project activities.

Equator Principles and International Finance Corporation Performance Standards

The Equator Principles are a voluntary standard for managing social and environmental risk in project financing transactions. The signatory Equator Principles Financial Institutions (EPFIs) are committed to following the ten Equator Principles, which in turn require adherence to (inter alia) the screening criteria of the International Finance Corporation's (IFC's) *Performance Standards on Environmental and Social Sustainability* (IFC 2012; hereafter 'IFC Performance Standards'). The IFC Performance Standards and their supporting Guidance Notes define client roles and responsibilities for managing development projects and the requirements for receiving IFC support.

TEP PNG is seeking Project alignment with the IFC Performance Standards.

Performance Standard 1 (IFC PS1) – *Assessment and Management of Environmental and Social Risks and Impacts*, requires that clients undertake a detailed assessment of the environmental and social risks associated with project development, and introduces the 'mitigation hierarchy' (avoid before minimize before compensate/offset) as the key approach for risk management.

Performance Standard 6 (IFC PS6) – *Biodiversity Conservation and Sustainable Management of Living Natural Resources*, whose requirements are guided by the Convention on Biological Diversity (Section 2.2.3), requires that environmental assessment focus on threats to key biodiversity values with an emphasis on habitat loss. Under IFC PS6 habitats are classified as Modified Habitat, Natural Habitat or Critical Habitat, with each habitat class triggering compliance with operational standards that differ in level of stringency. IFC PS6 also places emphasis on legally protected and internationally recognized areas, on the importance of controlling invasive alien species and on the management of ecosystem services.

Performance standard 6 includes guidelines on invasive alien species (weeds) which includes exotics and native species growing in areas where they are not normally found that can be a significant threat to biodiversity. The guidelines focus on the non-intentional introduction of any new weeds and the prevention of spread of weeds that are already established into new areas.

Other International Standards and Agreements

PNG is signatory to multiple additional international agreements related to the preservation of biodiversity and natural resources. The following are relevant to the flora components of the terrestrial biodiversity baseline study through their support of landscape- and/or species-level sensitivities:

- Convention on Biological Diversity (1992), ratified by PNG in 1993.
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (The Ramsar Convention, 1971).
- Convention on the Protection of Natural Resources and Environment of the South Pacific Region and related Protocols (Noumea, 1986).
- International Plant Protection Convention (Rome, 1952) with associated Plant Protection Agreement for the Asia and Pacific Region (Rome, 1956) as amended.

Total is a signatory to the International Petroleum Industry Environmental Conservation Association (IPIECA) and further adheres to the environmental principles set out in the United Nations Global Compact and in the OECD Guidelines for Multinational Enterprises. Relevant directives include environmentally sustainable development in accordance with applicable laws and ethical business practices, a precautionary approach to environmental risk management, and the development of management systems that cover baseline data collection, impact assessment, the establishment of conservation initiatives and monitoring of their outcomes.

TOTAL COMPANY STANDARDS AND COMMITMENTS

TEP PNG is guided by Total's *Code of Conduct* (Total 2014), a 'Priority Principle' of which is its commitment to "the highest Safety, Health, Security and Environmental standards wherever we operate". Total's biodiversity policy (outlined at www.total.com) centers on a "very clear objective…to avoid impacting biodiversity as much as possible throughout the entire life cycle of our facilities and products". This is achieved by "taking tangible measures to avoid, reduce, mitigate and, when necessary, compensate for any loss of biodiversity".

Company guidelines relevant to conducting baseline and impact assessment studies are outlined in the following General Specification documents:

- GS EP ENV 111: Environmental baseline and monitoring studies: onshore sites.
- GS EP ENV 120: Environmental impact assessment of E & P activities.

These guidelines have been considered in the development of the weeds study.

APPENDIX B - Vegetation Terminology

Table 1 Vegetation Terminology

Major vegetation group/FIMS code	FIMS Group/Description	Biodiversity Study term
Natural vegetation types		
Hill forest		
H	***Low altitude forest on uplands (below 1,000 m)***	***Hill forest***
Hm	Medium crowned forest	Hill forest
Hm.Ar	Medium crowned forest - Presence of *Araucaria* noted	Hill forest, *Araucaria* noted
Hm/Hs	Complex: Medium/Small crowned forest	Hill forest/small crowned hill forest
Hm/Sc	Complex: Medium crowned forest/Scrub	Hill forest/Scrub
Hs	Small crowned forest	Small crowned hill forest
Alluvial forest		
P	***Low altitude forest on plains and fans (below 1,000 m)***	***Alluvial forest***
Pl	Large to medium crowned forest	Alluvial forest
Po	Open forest	Open alluvial forest
Po/Fsw	Complex: Open forest/Mixed swamp forest	Open alluvial forest/Swamp forest
Po/Fsw/M	Complex: Open forest/Mixed swamp forest/Mangrove	Open alluvial forest/Swamp forest/Mangrove
Po/Wsw	Complex: Open forest/Swamp woodland	Open alluvial forest/Swamp woodland
Ps	Small crowned forest	Small crowned alluvial forest
Fri	***Seral forest***	
Fri	Riverine mixed successions	Riverine seral forest
Freshwater swamp habitats		
Fsw	***Swamp forest***	
Fsw	Mixed swamp forest	Swamp forest
FswC	Swamp forest with *Campnosperma*	Swamp forest with *Campnosperma*
Fsw/Gsw	Complex: Mixed swamp forest/Swamp grassland	Swamp forest/Swamp grassland
Fsw/M	Complex: Mixed swamp forest/Mangrove	Swamp forest/Mangrove
Fsw/Wsw	Complex: Mixed swamp forest/Swamp woodland	Swamp forest/Swamp woodland
W	***Woodland***	
Wsw	Swamp woodland	Swamp woodland
Wsw/Gsw	Complex: Swamp woodland/Swamp grassland	Swamp woodland/Swamp grassland
Wsw/Hsw	Complex: Swamp woodland/Herbaceous swamp	Swamp woodland/Herbaceous swamp
G/Hsw	***Grassland and herbland***	
Gri	Riverine successions dominated by grass	Riverine successional grassland
Gsw/Fsw	Complex: Swamp grassland/Mixed swamp forest	Swamp grassland/Swamp forest
Gsw/Wsw	Complex: Swamp grassland/Swamp woodland	Swamp grassland/Swamp woodland
Hsw	Herbaceous swamp	Herbaceous swamp
Hsw/Wsw	Complex: Herbaceous swamp/Swamp woodland	Herbaceous swamp/Swamp woodland
Marine tidal		
M	***Estuarine Communities***	
M	Mangrove	Mangrove

Littoral forest		
B	***Littoral forest***	
B	Mixed forest	Littoral forest
Non-vegetation/areas dominated by land use		
E	Lakes and large rivers	Rivers and lakes
O	Non-forest areas dominated by land use	Land use
U	Larger urban areas	Urban areas

APPENDIX C - Weeds Recorded by Survey Site

Table 1 Weeds Recorded by Survey Site

× = recorded; - = not recorded

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Tuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
THELYPTERIDACEAE	*Christella arida*	Fern	-	3	Fern to 1m forming sparse to dense infestations along roadsides. Appears to not significantly impact regeneration of trees	-	-	-	-	-	-	-	-	-	-	-	-	-	×	×	-	-	-	-	×	-	-
LYGODIACEAE	*Lygodium microphyllum*	Fern	Climbing maidenhair fern	2	A scrambling fern that climbs over vegetation forming localized infestations, particularly along logging roads	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	×	-	-	×	-
ADIANTACEAE	*Pteris sp.*	Fern		3	Common on cuttings	-	-	-	-	-	-	×	-	×	-	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Bothriochloa pertusa*	Grass	Beardgrass	3	A tufted grass, often in patches along degraded sites such as logging roads where well drained	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	×	-	-
POACEAE	*Cenchrus echinatus*	Grass	Mossman River grass	3	An annual grass to 50 cm. Seeds stick to clothes and animal fur facilitating spread. Mainly of nuisance value	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-
POACEAE	*Chloris inflata*	Grass	Purple-top chloris	3	Common on roadsides only.	×	-	-	-	-	-	×	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
POACEAE	*Dichanthium sp.*	Grass	Not known	3	Possible native or introduced pasture grass.	-	-	-	-	-	-	×	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Digitaria setigera*	Grass	Crab grass	3	Common on wellpads	-	-	-	-	×	×	×	-	-	-	-	-	×	-	-	×	-	×	-	-	-	-
POACEAE	*Echinochloa colona*	Grass	Barnyar grass	3	Weedy in wet sites	×	-	-	-	-	×	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Eleusine indica*	Grass	Crow's foot grass	3	Annual/perennial grass of roadsides and heavily disturbed areas.	×	-	-	-	-	-	-	-	-	×	-	-	×	-	-	×	-	×	-	-	-	-
POACEAE	*Eragrostis minor*	Grass	Small love grass	3	Occasional along roadsides	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Eragrostis tremula*	Grass	Chinese love grass	3	Occasional on disturbed sites	-	-	-	-	-	-	-	-	×	-	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Eragrostis unioloides*	Grass	Chinese lovegrass	3	Moderately common along roadsides	-	×	-	-	-	-	×	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Imperata cylindrica*	Grass	kunai	2	A naturalized grass that is invasive, particularly after fire.	×	×	×	-	-	-	×	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-
CONVOLVULACEAE	*Ischaemum muticum*	Grass	Sea shore centipede grass	3	A native grass. Common in the littoral zone. Occasional inland along tracks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-
POACEAE	*Ischaemum polystachum*	Grass	Paddle grass	3	Native grass. Common in patches along roadsides	-	-	-	-	-	×	-	-	-	×	-	-	×	-	-	-	-	×	-	-	-	-
POACEAE	*Megathyrsus maximus*	Grass	Guinea grass/Green panic	2	A dense tussock forming perennial along roadsides. Shade tolerant forming dense swards competing out native species	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
POACEAE	*Paspalum conjugatum*	Grass	Sourgrass	3	Common and widespread at most disturbed sites. Seen in semi-shade, but tolerant of full sun. Often along river banks	×	×	×	-	-	×	×	-	×	×	-	-	×	×	×	×	-	×	×	×	×	-
POACEAE	*Paspalum paniculatum*	Grass	Russel River grass	3	Perennial grass to 1m height in disturbed sites/tracks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	×	-	-	-	-
POACEAE	*Pennisetum purpureum*	Grass	Elephant grass	2	Tall grass, dominant along roadsides and elevated sections of river banks. Prefers full sun but reported as being present and persistent in tree fall gaps in other project areas	-	-	-	-	-	-	-	-	-	×	×	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Pennisetum sp.*	Grass	Not known	2	Tall grass present along logging roads near Camp B. Invasiveness not known	-	-	×	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
POACEAE	*Saccharum spontaneum*	Grass	Not known	2	Native grass forming dense stands to 3m height along roadsides	-	-	-	-	-	-	-	-	-	-	-	-	-	×	×	×	-	-	-	×	-	-
POACEAE	*Sacciolepis indica*	Grass	Glenwood grass	2	Perennial grass that favors open wet sites. Can compete out low growing native species	-	-	-	-	-	-	-	-	×	-	-	-	×	-	-	-	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
POACEAE	*Sacciolepis indica*	Grass	Cupscale grass	2	A perennial pasture grass to 1m, with spike like seed head, tolerates semi-shade. Prefers disturbance	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-	-	-	-	-
POACEAE	*Sporolobus sp.*	Grass	Rat's tail grass	3	Robust tufted perennial grass	×	×	×	-	-	×	-	-	×	×	-	-	×	-	-	-	-	-	×	-	-	-
POACEAE	*Urochloa mutica*	Grass	Para grass	2	A vigorous perennial grass to 2m height. Highly invasive on wetter sites where it can prevent regeneration of native species where rehabilitation is required	×	×	×	-	-	-	-	-	-	-	×	-	×	-	-	×	-	-	-	-	×	-
ASTERACEAE	*Ageratum conyzoides*	Herb	Blue-top	3	Annual herb widespread in open and semi-shaded areas on poorly drained sites such as abandoned wellpads	×	-	×	-	-	-	×	-	-	×	-	-	×	×	×	×	-	×	×	×	-	-
SCHROPHULARIACEAE	*Angelonia angustifolia*	Herb	Angelonia/Monkey face	1	Erect herb to 1m height. Forms dense stands on poorly drained sites such as abandoned wellpads	-	×	-	×	×	×	-	×	-	-	-	-	×	-	-	×	×	-	×	-	-	-
SCHROPHULARIACEAE	*Bacopa procumbens*	Herb	Baby jump-up	3	Prostrate to suberect creeping herb, favoring poorly drained sites such as abandoned	×	-	-	-	×	×	-	-	-	×	-	-	×	-	-	×	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
					wellpads. Shade tolerant sites. Ground creeper. Small yellow flower.																						
CANNACEAE	*Canna indica*	Herb	Indian shot	2	Perennial herb to 2.5m height. Forms dense patches. Planted as an ornamental. Red flowers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	×	-	-	-
AMARANTHACEAE	*Celosia argentia*	Herb	Celosia	2	Annual herb to 2m height. Can infest sandy/ stony riverbeds particularly during dry season. Habit degradation.	-	-	-	×	-	-	-	-	-	×	-	-	×	-	-	-	-	-	×	-	-	-
COMMELINACEAE	*Commelina benghalensis*	Herb	Hairy commelina	2	Can form localized infestations in riparian areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-
COMMELINACEAE	*Commelina diffusa*	Herb	Wandering Jew	2	A creeping herb that favors wetter sites. Spread vegetatively by regenerating from plant fragments. Forms localized infestations. Can be problematic in food gardens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-
ASTERACEAE	*Crassocephalum crepidioides*	Herb	Thick-head	3	Widespread, annual. Common in shaded sites but tolerates full sun.	-	×	×	-	-	-	×	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
FABACEAE	*Desmodium triflorum*	Herb	Threeflower tickrefoil	3	A creeping much branched herb of disturbed sites	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-
Caryophyllaceae	*Drymaria*	Herb	Tropical chickweed	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
	cordata																										
ASTERACEAE	*Eclipta prostrata*	Herb	False daisy	2	Common on poorly drained sites and wetlands	×	-	×	-	×	×	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-
PONTEDERIACEAE	*Eichhornia crassipes*	Herb	Water hyacinth	1	An erect perennial herb, free-floating or occasionally rooted in shallow water. Noted in Nea Creek and the having presumably floated downstream from the oxbow wetland. Can be confused with the native *Monochoria* sp. which is mostly rooted in mud and has slender leaf stalks	-	-	-	-	-	-	-	-	-	-	×	×	×	-	-	-	-	-	-	-	-	-
ASTERACEAE	*Emilia sonchifolia*	Herb	Emilia	3	Annual forb of abandoned and disturbed areas.	×	×	-	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-
ASTERACEAE	*Erigeron sumatrensis*	Herb	Sumatran fleabane	3	Moderately common along roadsides. Prefers full sun.	×	×	×	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	×	-	-
EUPHORBIACEAE	*Euphorbia heterophylla*	Herb	Milkweed	3	Occasional along roadsides	-	-	-	-	-	-	×	-	-	-	-	-	×	-	-	-	-	×	×	-	-	-
EUPHORBIACEAE	*Euphorbia hirta*	Herb	Asthma Plant	3	Prostrate perennial herb of bare soil sites adjacent to road verges.	×	×	×	-	-	-	×	-	-	×	-	-	×	-	×	×	-	-	-	-	-	-
EUPHORBIACEAE	*Euphorbia thymifolia*	Herb	Chicken weed	3	Small annual prostrate herb	×	-	-	-	-	-	×	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Tuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
RUBIACEAE	*Hedyotis corymbosa*	Herb	Mutiara	3	Perennial herb of abandoned sites/gardens. Full sun only.	×	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
CONVOLVULACEAE	*Ipomea aquatica*	Herb	Kang Kon	2	Herbaceous perennial forming dense beds on the open water edges of wetlands. Also occurs along logging roads but more sparsely distributed. Young shoots cooked and eaten as a vegetable	-	-	-	-	-	-	-	-	-	-	×	×	-	-	×	-	×	-	×	×	-	-
LINDERNIACEAE	*Lindernia crustacea*	Herb	Malaysian false pimpernel	3	Annual mat forming herb to 30 cm. Prefers wet disturbed sites. Shade and full sun.	×	-	-	-	×	-	-	-	-	×	-	-	×	-	-	×	-	-	-	-	-	-
ONAGRACEAE	*Ludwigia hyssopifolia*	Herb	Water primrose	2	Annual herb to 1-2 m. Favors wet sites where localized infestations can occur	-	-	-	-	-	-	-	-	×	-	-	-	×	×	×	-	-	×	-	×	-	-
ONAGRACEAE	*Ludwigia leptocarpa*	Herb	Anglestem willow	1	Annual herb. Can infest wet sites where exposed topsoil, e.g. pipeline reinstatement sites	-	-	×	-	-	-	-	-	×	-	-	-	×	-	-	-	-	-	-	×	-	-
ONAGRACEAE	*Ludwigia octovalis*	Herb	Willow primrose	2	Annual herb to 1-2 m. Favors wet sites where localized infestations can	-	×	×	-	-	×	×	-	-	×	-	-	×	-	-	×	-	-	-	-	×	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Tuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
					occur																						
POLYGONACEAE	*Persicaria attenuata*	Herb	Velvet knotweed	3	Native herb. Occasional occurrence in wetter sites	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-
SOLANACEAE	*Physalis angulata*	Herb	Wild gooseberry	3	Erect herbaceous annual to 50cm height. Can be shrub like	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-
SOLANACEAE	*Physalis minima*	Herb	Bubble fruit/Native gooseberry	3	Bushy annual to 50cm height. Can be shrub like	×	×	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
URTICACEAE	*Pilea microphylla*	Herb	Military fern	3	Prostrate, succulent and perennial. Only found in moist shaded areas, particularly in permanent camps	×	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
LAMIACEAE	*Plectranthus scutellarioides*	Herb	Coleus	2	Erect perennial herb often planted as an ornamental in permanent camps. Can establish in dense patches competing out regeneration in full sun conditions	-	-	-	×	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
POLYGALACEAE	*Polygala paniculata*	Herb	Polygala	3	A small erect annual herd. Favors wet disturbed sites	-	-	-	-	-	×	×	×	-	-	-	-	×	-	-	-	-	-	-	-	-	-
PORTULACACEAE	*Portulaca oleracea*	Herb	Pig weed	3	Prostrate annual herb. Occasional on disturbed sites	×	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
ASTERACEAE	*Sphagneticola trilobata*	Herb	Singapore daisy	2	Mat forming perennial herb to 70cm. Forms localized infestations competing out other plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-
ASTERACEAE	*Synedrella nodiflora*	Herb	Cinderella weed	2	Mat forming perennial herb to 70cm. Forms localized infestations competing out other plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-
ASTERACEAE	*Tithonia diversifolia*	Herb	Mexican sunflower	3	Shrub to 4m height. Can form dense thickets in wetter sites. More common in highland areas where it is a problem along roadsides. Seen at Wabo village only	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-	-	-	-
VERNONIACEAE	*Vernonia cinerea*	Herb	Veronia	3	Erect perennial herb to 70cm height. Occurs along roadsides	×	×	×	-	-	×	×	-	-	-	-	-	×	-	-	×	-	×	-	-	-	-
ARECACEAE	*Coconus nucifera*	Palm	Coconut	1	On raised microsites in mangroves, otherwise not a weed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×
CYPERACEAE	*Cyperus brevifolius*	Sedge	Mullumbimby Couch	3	Widespread, low-growing sedge of disturbed and wet areas. Requires full sun.	-	-	-	-	-	×	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-
CYPERACEAE	*Cyperus eragrostis*	Sedge	Flat sedge/tall nutgrass/umbrella sedge	3	Perennial sedge. Roadsides	-	-	-	-	-	×	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-

Family	Scientific Name	Life form	Common name	Priority	Notes	Herd Base	Kuku Creek Rd/Site 6A	Logging Rd (Site 3)	Ant 3 Base	Ant 1	Ant 2	Ant 3	Elk 1	Elk 2	Wabo & Station, Poroi 2	Wabo - Evara River Banks. Nea Creek, Kapuna	Oxbow	Purari airstrip	Logging Rd (Site 7)	Logging Rd (Aivai)	Logging Rd (near Purari strip)	Paevara	Avava to Muro Mission (Site 7)	Coastal village (Kavavu - Iuku-Herekela)	Dieback site	Disturbed forest	Mangrove forest
CYPERACEAE	*Cyperus esculentus*	Sedge	Nutgrass	3	Perennial sedge. Roadsides. Intolerant of shade	×	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-
CYPERACEAE	*Cyperus sp.*	Sedge	Not known	3	Perennial sedge	×	×	×	-	-	×	-	-	×	-	-	-	×	-	-	-	-	-	-	-	-	-
CYPERACEAE	*Fimbristylis dichotoma*	Sedge	Nut grass	3	A tufted perennial to 70 cm of wet conditions	-	×	-	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-
CYPERACEAE	*Fimbristylis sp.*	Sedge	Fringe-rush	3	Common widespread sedge of wet areas. Full sun only.	-	×	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-
FABACEAE	*Aeschynomene americana*	Shrub	Shyleaf	3	Annual or perennial herb to 2m height	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	×	-	-	-	-	-	-
FABACEAE	*Aeschynomene indica*	Shrub	Pannicle joint vetch	2	Erect perennial herb to 2m height. Forms small-scale dense infestations along roadsides on wetter sites	×	×	×	-	-	-	-	-	-	-	-	-	×	×	-	×	-	-	-	×	-	-
LAMIACEAE	*Clerodendron paniculatum*	Shrub	Pagoda flower	2	Semi-woody shrub to 3m height. Forms localized infestations. Planted as an ornamental	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-
MELASTOMATACEAE	*Clidemia hirta*	Shrub	Koster's curse	2	Can form localized infestations. Persistent in shade	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-
FABACEAE	*Crotalaria sp. (tall species)*	Shrub	-	2	Annual shrub to 3m. Forms localized infestations	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	×	×	-	-	-
FABACEAE	*Crotolaria sp.*	Shrub	Rattlepod, Gambia Pea	3	Small shrub in full sun areas.	-	×	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FABACEAE	*Desmodium heterocarpon*	Shrub	Asian ticktrefoil	3	Small shrub. Uncommon - occasional along	-	×	-	-	-	×	-	-	-	-	-	-	×	-	×	×	-	×	-	×	-	-

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					roadsides																						
LAMIACEAE	*Hyptis suaveolens*	Shrub	Hyptis	2	An annual shrub/woody herb to 3m. Can forms localized infestations along roadsides/disturbed sites	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-
FABACEAE	*Leucaena lecocephala*	Shrub	Coffee bush	3	Occurs along Purari river bank. Possible seed transported by waterways from the highlands. More invasive on drier sites	-	-	-	-	-	-	-	-	-	-	×	-	×	-	-	-	-	-	-	-	-	-
MIMOSACEAE	*Mimosa diplotricha*	Shrub	Creeping sensitive plant	3	A creeping/sprawling shrub. Mainly a weed of roadsides	-	-	-	-	-	-	-	-	-	×	×	-	×	-	-	-	-	-	-	-	-	-
MIMOSACEAE	*Mimosa pudica*	Shrub	Common sensitive plant	3	Low growing herb of disturbed areas. Requires full sun	-	×	×	-	-	-	-	-	-	×	-	-	×	×	×	×	-	-	×	×	-	-
PHYLLANTHACEAE	*Phyllanthus niruri*	Shrub	Stone breaker	3	Erect annual shrub like herb to 50cm. Can be common along roadsides	×	×	×	-	-	×	-	-	-	-	-	-	×	-	-	-	-	×	-	-	×	-
PHYLLANTHACEAE	*Phyllanthus sp.*	Shrub	Not known	3		-	-	×	-	-	-	×	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CAESALPINIACEAE	*Senna alata*	Shrub	Candle bush	2	Shrub to 4m height. Can form dense thickets in wetter sites	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	×	-	-	-	-
FABACEAE	*Senna occidentalis*	Shrub	Coffee senna	2	Woody shrub. Grows in full sun and partial shade. Long lived in soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-

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					seed bank																						
MALVACEAE	*Sida acuta*	Shrub	Spiny head sida	3	Short lived perennial shrub to 1m height. Often along roadsides	×	-	-	-	-	-	-	-	-	×	-	-	×	-	-	×	-	×	×	-	-	-
VERBENACEAE	*Stachytarpheta cayennensis*	Shrub	Snake weed	3	Perennial shrub to 1m height. Prefers wet sites, e.g. shaded creek lines	-	-	-	-	-	-	×	-	-	-	-	-	×	-	-	-	×	-	×	-	-	-
OXALIDACEAE	*Averrhoea bilimbi*	Tree	Bilimbi	2	Tree, planted for fruit. Dispersed along forest footpaths	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-
PIPERACEAE	*Piper aduncum*	Tree	Bamboo daka	1	Small tree to 6m. Tolerates range of climatic conditions and will grow in shade and full sun. Highly invasive and can establish in natural gaps and stream banks in primary forest	×	×	×	-	-	-	-	-	-	×	×	-	×	×	-	×	-	-	-	×	-	-
MYRTACEAE	*Psidium guajava*	Tree	Guava	3	Small tree bearing edible fruit. Seed widely dispersed by birds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	×	-	-
BIGNONIACEAE	*Spathodea campanulata*	Tree	African tulip tree	1	Large tree that can compete out native trees and degrade secondary forest	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-

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APOCYNACEAE	*Allamanda cathartica*	Vine	Golden trumpet vine/Yellow Allamanda	2	A vine that can form dense localized infestation climbing over small trees. Planted as an ornamental in villages where it has a shrub like appearance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	×	-	-	-
FABACEAE	*Calopogonium mucunoides*	Vine	Calopo	2	Annual vine with prostrate or twinning stems. A vigorous climber that can smother supporting vegetation such as regeneration	×	×	×	-	-	-	-	-	-	-	-	-	×	-	-	×	-	-	-	-	-	-
FABACEAE	*Centrosema molle*	VIne	Centro	2	Twining perennial vine, forming localized tangled infestations that can climb over small trees swamping regrowth. Requires full sun to thrive	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-
CONVOLVULACEAE	*Ipomea quamoclit*	Vine	Cypress vine	2	Annual twinning vine producing large amounts of seeds which germinate easily	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-	-	-	-
CONVOLVULACEAE	*Ipomea triloba*	Vine	Three lobe morning glory	3	Herbaceous annual twining vine. Can be a problem in food gardens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-
FABACEAE	*Macroptilium atropurpureum*	Vine	Siratro	3	Twining or prostrate	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-	-	-	-	-

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					perennial legume																						
FABACEAE	*Macroptilium lathyroides*	Vine	Phasey bean	3	Erect of climbing annual or biannual herb to 1.3m height	-	-	×	-	-	-	-	-	-	×	-	-	×	-	×	-	-	-	-	×	-	-
CONVOLVULACEAE	*Merremia peltata*	Vine	Merremia/Big lip vine	2	Perennial vine that can smother the canopy of large trees. Possibly a naturalized species	×	×	×	-	-	-	×	-	-	×	-	-	×	×	×	×	-	-	-	×	-	-
ASTERACEAE	*Mikania micrantha*	Vine	Mile a minute vine	1	Tolerates semi-shade and a common invader of low-moderately disturbed areas, particularly in wet areas. Highly invasive and can smother the canopy of large trees. A problem in food gardens at Evara village	×	×	×	-	-	-	-	-	-	-	-	-	×	×	×	×	-	-	×	×	-	-
CUCURBITACEAE	*Momordica charantia*	Vine	Balsam pear	2	Herbaceous annual vine to 6m height. Can form localized infestations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	×	×	-	-	-
PASSIFLORACEAE	*Passiflora foetida*	Vine	Wild passionfruit	3	Herbaceous perennial vine. Used to interplant crops	×	-	×	-	-	×	-	-	-	×	-	-	×	-	-	×	-	×	×	-	-	-
FABACEAE	*Pueraria montana*	Vine	Kudzu	2	A native vine. Can cause localized infestation on forest edges and swamp grasslands	-	-	-	-	-	-	-	-	-	-	-	-	-	×	-	-	-	-	-	-	-	-

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FABACEAE	*Pueraria phaseoloides*	Vine	Tropical kudzu	2	A vigorous fast growing vine that can that can cover the canopy of trees. Common along roadsides	-	×	×	-	-	-	×	-	-	×	-	-	×	-	-	-	-	-	-	-	-	-